REMARKS

The above amendments to the above-captioned application along with the following remarks are being submitted as a full and complete response to the Office Action dated October 17, 2003 (U.S. Patent Office Paper No. 10). In view of the above amendments and the following remarks, the Examiner is respectfully requested to give due reconsideration to this application, to indicate the allowability of the claims, and to pass this case to issue.

Status of the Claims

As outlined above, claims 1, 3, 11, 14, 16, and 19 are being amended to correct formal errors and to more particularly point out and distinctly claim the subject invention. Applicants hereby submits that no new matter is being introduced into the application through the submission of this response.

Prior Art Rejections

Claims 1, 5, 6, and 9 were rejected under 35 U.S.C. §103(a) as being unpatentable over Sasaki *et al.*, U.S. Patent No. 5,607,718 (further, Sasaki '718) in view of Moriyama *et al.*, U.S. Patent No. 6,180,020 B1 (further, Moriyama '020).

Applicants respectfully traverse the rejection and submit that the process for producing a semiconductor device as now recited in amended claim 1 comprises the steps of using a grindstone formed of abrasive grains and a resin binder for binding and retaining the abrasive grains, feeding a dispersant containing processing liquid to a surface of the grindstone, and polishing and planarizing the surface of a semiconductor wafer so as to expose at least two different thin films formed on the surface of the semiconductor wafer during a part or whole of processing time, wherein said grains have average grain size of 0.1-0.4 μm and at least 99% of said grains are in a range of grain size of 1 μm or less, and said processing liquid is free of abrasives, and wherein said dispersant enables improving a polishing selectivity between said two different thin films.

Applicants also submit that the present invention discloses a polishing method using a grindstone, in which:

- the most suitable range for particles' diameter is between 0.1 and 0.4 μm;
- a hard inorganic oxide, such as cerium, is used for polishing particles;
- the additive agent improves uniformity of polishing and selective ratio. The present invention discloses polishing of two kind of films which are made of SiO_2 and SiN, respectively; polishing is performed while having selectivity.

According to the present invention, the use of both grindstone and dispersing agent makes the polishing capable of having high flattening performance, achieving excellent uniformity and having the highest selectivity possible. Polishing particles are not contained in the polishing liquid applied to a grindstone. The uniformity of polishing is achieved and improved by using a dispersing agent for dispersing polishing particles. The method of the present invention is applied to a grindstone comprising fine polishing particles, especially with diameters of less than 1 μm, which is known to exhibit very advantageous effects. The use of a grindstone, is "a physical processing". The polishing particles are hardened and are used to chip away a workpiece. The present invention recites the use of soft organic high molecular material. Organic high molecular materials are used as a binder with the purpose of fixing abrasives and they do not contribute to polishing. The reason why this additive is elected is because it has excellent planarity and eliminates the problems induced by grindstone polishing such as the deterioration of the equality of polishing. The additive also helps increase the removal rate and to reduce the selection rate. The present invention discloses the polishing being performed by grindstone polishing, especially when polishing is done for two kinds of hard films, SO_2 and SiN, as recited by amended claim 1 and its dependent claims.

Sasaki '718 discloses a step of polishing a metal film performed by free polishing particles using slurry containing polishing particles in a polyurethane polishing pad. Sasaki '718 discloses that ammonium polycarboxyl is added as a technique for dispersing organic high-molecular polishing particles in a slurry using a polyurethane polishing pad or for enhancing the pH-rate of metallic CuO_x. In polishing using a polyurethane polishing pad according to Sasaki

'718, the polishing particles of a slurry are coagulated and settled so as to change the slurry's properties in some cases. A dispersing agent is used to improve the dispersibility of the slurry and to prevent deterioration with age.

Sasaki '718 recites the use of hard inorganic oxides as abrasives. Further, Sasaki '718 discloses the use of a polyurethane polishing pad for polishing soft metal films. Sasaki '718 recites the use of fine abrasives having particle diameters of 0.01 - 0.1 μm. Due to their fine diameters, they have high manufacturing costs, a process cost based on transportation costs, distribution costs, and a cost for preventing agglomeration in its distribution system. The cost of using a slurry with these particles for polishing is much higher in comparison to using a grindstone for polishing.

Applicants respectfully submit that the primary reference Sasaki '718 does not anticipate the present invention as recited by claim 1 because it fails to disclose, teach or suggest each and every element of the claimed invention. Sasaki '718 fails to show using a grindstone to physically polish two thin films formed of abrasive grains and a resin binder. As shown above Sasaki '718 uses a slurry containing polishing particles embedded in a polishing pad to chemically polish a metal film. In addition, Sasaki '718 does not anticipate the present invention as recited in claim 1 because does it clearly fails to disclose, teach or suggest a processing liquid free of abrasives and a dispersant that enables improving polishing selectivity between the two thin films exposed on the surface of the semiconductor wafer.

Moriyama '020 discloses a polishing method using a grindstone formed by polishing particles bound by phenolic resin and performed by supplying a polishing liquid including either pure water, acid or an alkaline polishing liquid. The grindstone polishing disclosed by Moriyama '020 achieves excellent flattening and but has inferior performance results when it comes to obtaining uniformity. Pure water, acid or alkaline water are used as polishing liquids.

Applicants respectfully submit that the secondary reference of Moriyama '020 does not anticipate the present invention as recited in claim 1 because it does not disclose, teach or suggest the use of a dispersant that enables improving a polishing selectivity between said two different thin films.

Based on the above, Applicants respectfully submit that none of the references on which the rejection relies do not identically disclose, teach or suggest the present invention as recited in claim 1 either individually or in combination. Further, none of the cited references provides any motivation to combine their teachings so as to embody every feature of the present invention as claimed.

Even if for the purposes of the argument it were considered obvious to combine the the polishing method that uses free polishing particles using slurry containing polishing particles in a polyurethane polishing pad of Sasaki '718 with the polishing method of Moriyama '020 that uses a grindstone formed by polishing particles bound by phenolic resin, the combination still does not disclose, teach or suggest the present invention. In particular there is still no suggestion or teaching about the dispersant recited in claims 1, that enables the improving of polishing selectivity between said two different thin films.

Accordingly, for at least the above reasons, Applicants respectfully submit that independent claim 1 is patentable over the combination of Sasaki '718 and Moriyama '020. Dependent claims 5, 6, and 9 are also patentable for at least the reasons given above with respect to independent claim 1 and further in view of their own respective features.

Claims 2 and 10 were rejected under 35 U.S.C. §103(a) as being unpatentable over Sasaki *et al.*, U.S. Patent No. 5,607,718 (further, Sasaki '718) in view of Moriyama *et al.*, U.S. Patent No. 6,180,020 B1 (further, Moriyama '020) and further in view of Hosali *et al.*, U.S. Patent No. 6,132,637 (further, Hosali '637).

Claims 2 and 10 depend from and add features to independent claim 1. Claim 1 is believed as shown above to be allowable over the combination of Sasaki '718 and Moriyama '020 for reasons described above in response to the rejection of claim 1. Therefore, claims 2 and 10 are also allowable over any combination of references that has as primary and secondary reference Sasaki '718 and Moriyama '020.

In addition, Applicants respectfully submit that claims 2 and 10 add to claim 1 the following features: said at least two different thin films include a film mainly containing silicon dioxide and a film mainly containing silicon nitride and the grindstone including, cerium

dioxide, aluminum oxide, silica, zirconium oxide, manganese oxide, titanium oxide or magnesium oxide or mixture thereof as the abrasive grains is employed.

Applicants respectfully submit that the present invention discloses that a chemical effect based on a dispersing agent is employed by applying ultrafine polishing particles, having a diameter of smaller than l μm to a grindstone and further adding a dispersing agent containing no polishing particles to a polishing liquid so as to improve the selective ratio of polishing of an oxide film or a nitride film and further to be able to obtain high flattening performance using a grindstone. Further, the present invention discloses the polishing being performed by using the grindstone. The grindstone comprises ultrafine particles having a diameter smaller than 1 μm than are different from silica. A dispersing agent containing no polishing particles is added to a polishing liquid, thereby allowing a dispersing agent to be added to the polishing grindstone comprising cerium particles and the polishing liquid containing no polishing particles so as to improve polishing selective ratio and flattening performance.

Applicants respectfully submit that both Sasaki '718 and Hosali '637 disclose polishing based on free polishing particles performed using a slurry containing the polishing particles in a polyurethane polishing pad. Moriyama '020 discloses a polishing method using a polishing grindstone formed by polishing particles bound with a phenolic resin and supplied with pure water, acid or alkali polishing liquid. Further, Moriyama '020 discloses a method of polishing a silicon oxide film using a polishing grindstone, an acid or an alkali polishing film.

Hosali '637 also discloses that the polishing speed of a silicon oxide film and a silicon nitride film is being improved by adding a dispersing agent to the slurry containing cerium.

Based on the above, Applicants respectfully submit that none of the references on which the rejection relies nor their combination discloses all the features of claim 1 and of its dependents 2 and 10. Therefore, claim 1, 2 and 10 are allowable over the combination of references.

Claims 2, 3, 4, and 8 were rejected under 35 U.S.C. §103(a) as being unpatentable over Sasaki *et al.*, U.S. Patent No. 5,607,718 (further, Sasaki '718) in view of Moriyama *et al.*, U.S.

Patent No. 6,180,020 B1 (further, Moriyama '020) and further in view of Kimura, U.S. Patent No. 5,869,392 (further, Kimura '392).

Claims 2, 3, 4, and 8 depend from and add features to independent claim 1. Claim 1 is again believed as noted above to be allowable over the combination of Sasaki '718 and Moriyama '020 for reasons described above in connection to claim 1. Therefore, claims 2, 3, 4, and 8 are also allowable over any combination of references that has as primary and secondary reference Sasaki '718 and Moriyama '020.

The arguments made above in connection with the rejection formulated against claims 1, 2, and 10, apply. In addition, Applicants would like to bring to the Examiner's attention the following facts: Previously and currently amended claims dependent claims 2, 3, 4, and 8 add the following features to the process recited by claim 1: said at least two different thin films include a film mainly containing silicon dioxide and a film mainly containing silicon nitride; a concentration of the dispersant in the processing liquid is changed during processing for changing a polishing selectivity between said two different films; and at least 99% of the abrasive grains have a particle size of 0.001 μm or greater but not greater than 1 μm and the concentration of ammonium polyacrylate ranges from 0.05 wt. % to 5 wt. %.

Applicants respectfully submit that the molecular weight of a dispersing agent is not a parameter of general polishing and influences only the coefficient of viscosity of the processing liquid. It is difficult to determine the coefficient of viscosity for a slurry containing polishing particles without knowing any limitations. In the captioned invention, the most suitable coefficient of viscosity could be first determined since the processing liquid contains no polishing particles.

Applicants respectfully submit that Sasaki '718 discloses a method of polishing a metal film based on free polishing particles. The polishing is performed using slurry containing polishing particles embedded in a polyurethane polishing pad. The polyurethane pad polishing method is used as a general technique for dispersing organic high polymer polishing particles in a slurry, or adding an ammonium polycarboxile for enhancing pH-rate of a metal CuO_x. The polishing method using a polyurethane polishing pad of Sasaki '718 presumes that polishing particles of a slurry are coagulated and settled so as to change their properties in some cases, and

a dispersing agent is used for improving the dispersability of the slurry and to prevent deterioration with age.

Moriyama '020 discloses a polishing method performed by using a polishing grindstone formed of polishing particles bound by phenolic resin and supplied with pure water, acid or alkaline polishing liquid. The grindstone polishing method of Moriyama '020 has excellent performance of flattening and inferior results to a uniformity thereof, pure water, acid or alkaline water is used as polishing liquid.

Kimura '392 discloses a material for polishing that changes its pH, a composition for a polishing liquid, mechanical pressure being exerted, a concentration of slurry in a polishing liquid, a rotational speed of a polishing cloth. However Kimura '392 does not disclose, teach or disclose that polishing selective ratio of an acid film and of a nitride film is changed by changing the concentration of the dispersing agent in the polishing liquid that does not contain slurry and uses a polishing grindstone with cerium polishing particles.

Further, given all the references discussed above, none of these references provides any disclosure or suggestion that would motivate their combination such that they would embody every feature of the claimed invention. Even if for purposes of the argument it were considered obvious to combine the disclosure of Sasaki, Moriyama and Kimura, the combination still does not teach the present invention as recited by claim 1 and dependent claims 2, 3, 4, and 8. Therefore, Applicants contend that the claims are allowable for the reasons exhibited above and for reasons contained therein and respectfully ask the Examiner to withdraw the rejection regarding these claims.

Claims 11 to 13, 14, 15, 16, 17 were rejected under 35 U.S.C. §103(a) as being unpatentable over Sasaki *et al.*, U.S. Patent No. 5,607,718 (further, Sasaki '718) in view of Moriyama *et al.*, U.S. Patent No. 6,180,020 B1 (further, Moriyama '020) and of Hosali *et al.*, U.S. Patent No. 6,132,637 (further, Hosali '637) and further in view of Kimura, U.S. Patent No. 5,869,392 (further, Kimura '392).

Amended claim 11 recites a process for producing a semiconductor device, comprising the steps of using a grindstone formed of abrasive grains and a resin binder for binding and

retaining the abrasive grains, feeding a dispersant containing processing liquid to the surface of the grindstone, and polishing and planarizing the surface of a semiconductor wafer over which a silicon nitride film and a silicon oxide film have been stacked one after another, wherein said grains have average grain size of 0.1- 0.4 μm and at least 99% of said grains are in a range of grain size of 1 μm or less, and said processing liquid is free of abrasives, wherein the dispersant has a concentration permitting a removal rate ratio of the silicon oxide film not less than 20 relative to the silicon nitride film.

Amended claims 14 and 16 recite the same steps for the process of producing a semiconductor device but what differ are several limitations regarding the grain size and the dispersant. More precisely, claim 14 recites: "wherein said grains have average grain size of 0.1-0.4 μm and at least 99% of said grains are in a range of grain size of 1 μm or less, and said processing liquid is free of abrasives, and wherein the dispersant is fed at a low concentration at an initial stage of polishing for high removal rate of said silicon oxide, followed by an increase in the concentration for high selectivity of removal rate of said silicon oxide to said silicon nitride". Claim 16 recites regarding the grain size and the dispersant: "wherein said grains have average grain size of 0.1-0.4 μm and at least 99% of said grains are in a range of grain size of 1 μm or less, and said processing liquid is free of abrasives, and wherein the processing liquid is supplied while setting the concentration of the dispersant within a range permitting a removal rate of the silicon nitride film once decreased to a low level and maintained at substantially the same low level and a removal rate of the silicon oxide film once increased to a high level and maintained at substantially the same high level". In addition, the present invention discloses a polishing method using a grindstone, in which the most suitable range of particles' diameter is from 0.1 to 0.4 μm, a hard inorganic oxide, cerium, is used for polishing particles, and the additive agent improves uniformity of polishing and selective ratio. According to the present invention, two kind of films, a SiO_2 film and a SiN film are polished while having achieving selectivity. All the arguments made above in response to rejections regarding claims 1 to 10 apply in response to the above rejection.

All the arguments made above in response to rejections regarding claims 1 to 10 apply in response to the above rejection. In addition Applicants respectfully submit that none of the references on which the rejection relies, either independently or in combination, disclose, teach

or suggest all the features recited by the claims referenced above. None of the references cited above discloses that "said grains (comprised by the grindstone) have average grain size of 0.1-0.4 μm and at least 99% of said grains are in a range of grain size of 1 μm or less, and said processing liquid is free of abrasives".

The differences between the subject matter disclosed by these claims and the cited references are the same as the ones outlined in response to the previous rejections. Further, with respect to controlling the additive concentration during working by using a grindstone pad, an important advantage by the present invention is that in a slurry, the additive's concentration needs to be coordinated with the slurry's stability (agglomerate and surface active in a long time) and cannot be selected by only selection rate to the polished work piece. For example, if the selection rate of the polished work piece is very high and the concentration of dispersant is high, the absorption degree of dispersant to the abrasive surface is high (therefore, the selection rate is also high), such that micell is formed in the slurry. Further, agglomerate does not maintain stability. When the concentration of dispersant is low, the agglomerate deteriorates. In Sasaki '718, Hosali '637 and Kimura '392, the concentration of dispersant is limited by restrictions on the slurry's stability, while in the grindstone pad, as in the present invention, there is no slurry used, so the restriction related to its dispersion does not exist. The concentration of dispersant can be changed, as disclosed by the present invention, with remarkable advantages especially in combination with the grindstone pad. Applicants respectfully submit that this advantage is not disclosed, taught or suggested by Sasaki '718, Hosali '637 or Kimura '392. Therefore, based on the argument made above Applicants respectfully submit that the above referenced independent claims along with their dependent claims 12, 13, 15, 17 and 18 are allowable over the references made of record and over their combination.

Claim 19 was rejected under 35 U.S.C. §103(a) as being unpatentable over Sasaki *et al.*, U.S. Patent No. 5,607,718 (further, Sasaki '718) in view of Moriyama *et al.*, U.S. Patent No. 6,180,020 B1 (further, Moriyama '020)and of Hosali *et al.*, U.S. Patent No. 6,132,637 (further, Hosali '637).

Applicant respectfully traverse the rejection and submit that the production process of a semiconductor device, as now recited by amended claim 19, recites the following steps: forming

a silicon nitride film over a semiconductor substrate and then forming a trench for isolation region in the semiconductor substrate, forming an insulating film over said trench for isolation region and said silicon nitride film, and using a grindstone formed of abrasive grains and a resin binder for binding and retaining the abrasive grains feeding a dispersant containing processing liquid to the surface of the grindstone, polishing the surface of the semiconductor substrate, thereby planarizing said insulating film, and leaving the insulating film only in said trench for isolation region, and removing the silicon nitride film from the substrate in a region other than the isolation region, wherein said grains have averse gain size of 0.1-0.4 μm and at least 99% of said grains are in a range of grain size of 1 μm or less, and said processing liquid is free of abrasives, and wherein said dispersant enables to improve a polishing selectivity between said insulating film and silicon nitride film.

Applicants respectfully submit that all the arguments made above in response to the rejection regarding claims 1, 11, 14, and 16 and respectively their dependent claim apply. In addition, regarding the application of the disclosed process to a semiconductor fabrication, the present invention as disclosed in claim 19 is different from Sasaki '718, Moriyama '020 and Hosali '637 due to the advantageous effects induced by the utilization of a high planarity polishing device. In contrast to Sasaki '718 and Hosali '637, the present invention does not use a polyurethane polishing pad and a slurry. The present invention uses a stone having high planarity. Even after lengthy polishing, dishing does not appear. This allows the process to be used for forming a reverse pattern of an element, or back etching. The present invention shows advantages not disclosed by neither reference or by their combination by achieving short periods and low costs for a manufacturing process thereof by using a grindstone and a dispersant. Due to the above outlined advantages that are not disclosed, taught or suggested in any of the references, the subject matter disclosed by claim 19 is distinguishable over the references. Applicants respectfully ask the Examiner to reconsider its rejection regarding claim 19.

Claims 20 to 22 were rejected under 35 U.S.C. §103(a) as being unpatentable over Sasaki *et al.*, U.S. Patent No. 5,607,718 (further, Sasaki '718) in view of Moriyama *et al.*, U.S. Patent No. 6,180,020 B1 (further, Moriyama '020) and of Hosali *et al.*, U.S. Patent No. 6,132,637 (further, Hosali '637) and further in view of Kimura.

Claims 20 to 22 depend from and add features to independent allowable claim 19. Therefore, they are also allowable for at least the reasons discussed above in connection with claim 19.

Conclusion

In view of all the above, Applicants respectfully submit that certain clear and distinct differences as discussed exist between the present invention as now claimed and the prior art references upon which the rejections in the Office Action rely. These differences are more than sufficient that the present invention as now claimed would not have been anticipated nor rendered obvious given the prior art. Rather, the present invention as a whole is distinguishable, and thereby allowable over the prior art.

Favorable reconsideration of this application as amended is respectfully solicited. Should there be any outstanding issues requiring discussion that would further the prosecution and allowance of the above-captioned application, the Examiner is invited to contact the Applicant's undersigned representative at the address and phone number indicated below.

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